

# MASSAGE IN NERVOUS DISEASES.

## I.

### PHYSIOLOGY.

BY DR. GEORGE W. JACOBY.

PHYSICIAN TO THE CLASS OF NERVOUS DISEASES OF THE GERMAN DISPENSARY OF THE CITY OF  
NEW YORK.

#### *Introduction.*

THAT the question of the influence of massage upon the nervous system is a perfectly legitimate one, must be acknowledged. The advantages which are claimed to have accrued to other specialties through its use are so great, that we neurologists are naturally anxious to discover whether we also may not find it a valuable adjuvant. Nervous diseases are frequently so obdurate, and their treatment so perplexing, that it is necessary to have at our command every therapeutic agent that offers any increased hope of success. In order to establish its actual value it will be necessary to specify as clearly as possible the indications for its use, and also to oppose the exaggerated hopes and assertions of certain authors. Years of experience and practice are necessary in order to gain a clear idea of its action, and not to be misled by apparent results, which would probably have been attained by any other remedy. It is a fact worth meditating upon, that as yet we have not decided upon the value or worthlessness of massage in these affections, and that such a work of revision and inquiry should still be requisite. As a reference to any general work upon massage will show, we are not dealing with a new the ra-

peutic measure, or with one which has lately been applied as such, but with one which is among the oldest, and which is probably even older than medical literature itself. The manuscript evidence of its use dates back to three thousand years B.C., and traditional proof of its existence is still older than the documentary evidence.

The history of the use of massage in diseases of the nervous system can be told in a few words. According to *Plutarch*, Julius Cæsar subjected himself daily to a pinching of the entire body, as a means of relief from a general neuralgia. *Celsus* says: "Chronic pains of the head are relieved by rubbing the head itself." "A paralyzed limb is strengthened by being rubbed."

*Paullini* ("Flagellum Salutis," 1698) cites historical passages which show that flagellation, percussion, *claquement*, and *ebranlement*, have cured melancholia, insanity, paralysis, and epilepsy. But as he also claims that deafness, tooth-ache, luxation of the maxilla, deaf-mutism, goitre, empyema, pleurisy, obstinate hiccoughs, irregular menses, and many more ills that flesh is heir to, have been cured by this means, we can only mention it as having historical interest without further criticising the value of the testimony.

In 1808 *John Barklays*, in an essay upon the muscular actions of the body, published in Edinburgh, relates a case of severe muscular contracture which, not being curable by any other means, was finally cured by beating of the sternocleido.

In 1818 *Piorry*, in the "Dictionnaire de Médecine," published in sixty volumes, spoke of the anæsthetic actions of massage, and even relates the following case in support:

"The wife of one of the most distinguished savants with which France is honored, is relieved from a severe rheumatic pain to which she is subject, only when a pressure analogous to massage, is exercised upon the affected part. This remedy is not curative with her, but it is certain that it relieves the pain."

*Balfour*, Edinburgh, 1819, in a book entitled "Illustrations of the Power of Compression and Percussion in the Cure of Rheumatism, Gout, and Debility of the Extremities,

and in Promoting Health and Longevity," makes some general remarks which approach modern accepted ideas. In 1837 *Dr. Martin* addressed a *Mémoire* to the Société de Médecine, in which he extols the action of massage in lumbago, and mentions over one hundred cases which were benefited by this means.

About thirty years ago Meding used massage successfully in the treatment of writers' cramp. These few facts, notwithstanding that they should have been sufficient to at least attract attention to the action of massage in nervous diseases, were until within a very few years all that was known upon the subject.

The general literature of massage is very large, particularly among those nations by whom it was soon accepted—namely, Norway, Sweden, France, and England. It is only since about ten years that this method has been recognized by Germany; and American authors, with the exception of Douglas Graham, of Boston, have paid it very little attention. As regards its relations to nervous diseases, we can find very little; nothing which would entitle us to a positive opinion as to its value. One author attaches more importance, another less, according to individual dexterity and the amount of experience.

#### PHYSIOLOGY.

The question as to the physiological action of massage is probably the most important; without a thorough comprehension of its *modus operandi*, its successful application, no matter how dexterous we may be mechanically, will be a matter of impossibility. The form to be used, the velocity of the blows in *tapotement*, the force of the beat, or the lightness of the touch,—in short, the discrimination between minutiae, which is so essential, cannot be effected unless we are able to satisfactorily answer the question which we should always propound to ourself in a given case: "What do you desire to accomplish?" The manner of doing it is entirely secondary, and is a natural result of the correct answer to our question.

The general physiology of massage is, if we are expected.

to believe all the results claimed to have been obtained, almost commensurate with physiology itself. Indeed, in order to explain all these successes, it would be necessary not only to bring into requisition all that is known of general physiology, but also then to confess our inability and ignorance in regard to many points. The older writers explained all the phenomena produced by massage by saying: "It increases the action of the skin, it strengthens the muscles, and decreases nervous irritability." Just what was explained by this paraphrasing probably no one knows, notwithstanding the fact that a very recent book upon the subject eludes explanation by a similar system.

It is essential to be on our guard against theories; the only deductions permissible are those from facts. When a person argues, as *Neumann* does,—“Since peristaltic contractions of the stomach may be increased by excitation of the pneumogastric and the parts of the brain where it originates, therefore in chronic gastric affections pressure upon the pneumogastric and beatings of the back of the head are useful,”—then indeed is it imperative for us to separate the chaff from the wheat. It is not the object of this paper to enter at all into the general physiology of massage, but only to attempt to show in how far and in what way massage is capable of influencing the nervous system, either directly or indirectly. Its influence may be produced directly by :

- a. Nerve or muscle stimulation (excitant action).
- b. By nerve or muscle depression (sedative action).

Indirectly by :

- a. Action upon the lymphatic system.
- b. Local or general action upon the blood current.
- c. Reflex action.

We will first consider its indirect action.

#### I.—ACTION UPON THE LYMPHATICS.

Through the labors of *Ludwig* and his pupils we have become thoroughly acquainted with the physiology of the lymphatics and the laws which govern the flow of lymph. We know that the motion of this current is brought about

by various factors, chief among which is the action of the muscles between whose tendons the lymphatics take their course. While the muscles are at rest the flow of lymph is very sluggish, but as soon as muscular action is developed, an increase in its rapidity takes place. *Colin* ("Traité de physiologie comparée des animaux domestiques," Paris, 1856) has practically and conclusively proven that muscular movements do exert this action. He found that when a tube was introduced into any of the lymphatic vessels of the neck in the larger ruminants, the discharge of fluid during a certain period of time, was from one fourth to one half greater during mastication than during repose. If, then, muscular action in general has this effect, we would be justified in expecting a similar result from massage, and that massage does increase the rapidity of the lymph current is shown by the experiments of *Lassar* (Ueber oedem und Lymphströmung bei der Entzündung, *Virchow's Archiv*, B. 69, xxix., p. 516) and by those of *v. Mosengeil* (Verhandl. der Deutschen Gessellschaft für Chirurgie, 4th Congress, Berlin, 1875, pp. 159 and 160).

*Lassar* produced an artificial inflammation in the paws of dogs. The principal vessels were then severed. If passive movements were then executed with the inflamed limb, or massage applied to it, the lymph poured out in a stream from the divided ends of the vessels. An analogous effect may also be produced upon the lymphatic glands. Whereas electrical excitation has no influence upon their secretion, mechanical irritation produces a strong flow of lymph. We thus see that massage has a direct influence upon the acceleration of the lymph current, and therefore promotes the absorption of pathological products. *V. Mosengeil's* experiments clearly elucidate this last point. Into various joints of rabbits he injected a concentrated solution of black india ink. Certain joints were then massaged repeatedly, and others, for purposes of comparison, were not treated at all. The swelling, which occurred after the injection, disappeared much sooner from the massaged joints than from those not so treated. The animals were then killed and the joints opened. Those joints which had been manipulated during

a certain period of time were found to be entirely free from the ink, whereas a considerable amount of ink was present in those which had not been treated. Numerous deposits of ink were found also in the interstices of the muscles and along the course of the lymphatics for a considerable distance above the joint. Upon the non-massaged limbs these deposits were entirely absent. The crural and subcrural muscles in particular were the seat of a black inky discoloration, whereas upon the non-massaged limb they retained their normal red color. The centrally situated lymphatic glands of the massaged extremity were colored intensely black, and the lymphatics leading to them were prominently designed as black cords. These deposits of color were entirely absent upon the other limb. By these experiments, therefore, it was distinctly shown that the absorption of normal and pathological products by the lymphatics is very much aided by massage.

V. Mosengeil very strikingly compares the mechanical action of massage upon the lymphatics to the action of strokings executed upon an elastic rubber tube which is filled with fluid, the lower end of it being immersed in a reservoir of the same. The continuous advancing pressure thus forces the fluid forward; that part of the tube then from which the pressure has been removed as the hand glides forward, becomes dilated by its own elasticity, and sucking up the fluid from the reservoir, thus refills itself. The conditions in the human body are, if any thing, even more favorable than this, for here the veins and lymphatics are supplied with valves which prevent a retrogression of the fluid.

We are therefore entitled to conclude that :

1. Massage accelerates the flow of the lymph current.
2. Massage sometimes produces, always aids, the absorption of pathological products, which are through it forced into the centripetal lymphatics.

## 2.—ACTION UPON THE CIRCULATION.

The action of massage upon the circulation is produced in various ways. The lighter manipulations, such as light

*effleurage* for instance, act in very nearly the same manner as any irritation of the skin ; and that dermal irritants have an indirect action upon the circulation is well known. The experiments of *Naumann*, *Schede*, and others, show that weak irritation of the skin produces contraction of the vessels, and consequently an increase in the velocity of the blood current. Strong irritants produce the reverse—a dilatation of the walls of the vessels, and therefore, as a direct result, a retardation in the rapidity of the current. If we were to apply these facts directly to the lighter manipulations, our inference would be : weak *effleurage* produces increased rapidity of the blood current ; strong *effleurage* decreases its rapidity. We have, however, another factor which enters into consideration, and that is the purely mechanical action of *effleurage*. By this action the blood is forced directly forward and the action of strong *effleurage* is antagonized. Therefore our second deduction is incorrect. Practically, what we find is, that *effleurage* in any form increases the rapidity of the blood current.

The stronger forms of massage, such as *pétrissage* and *tapotement*, act in a different way ; their action upon the vaso-motor nerves and upon the muscular fibres of the walls of the vessels is analogous to that produced by other modes of irritation. The innervation of blood-vessels, we know, is brought about in two ways : first, by ganglia in their walls, and secondly, by exterior nerves which when irritated have an influence upon the lumen of the vessel.

These ganglia and nerves, as well as the muscular fibres in the walls, may be acted upon either directly or indirectly. The direct action of mechanical irritation upon them is shown very nicely by Goltz's "Klopfversuch." By means of this well-known experiment Goltz showed that there is produced a change in the vessels themselves which chiefly concerns their contractility, and which is entirely independent of the action produced reflexly upon the heart by means of the pneumogastric. If the abdomen of an animal upon whom this experiment has been performed be opened, the vessels of the peritoneum as well as those of the abdominal cavity will be found dilated and distended with blood.

This is particularly noticeable upon the veins. The result of this species of tapotement, or beating, is, then, a distension of the vessels due to paralysis of their walls. If this same experiment be performed upon an animal with an opened abdomen, so that the changes take place directly under our observation, the blows being applied to the stomach and intestines, we notice at first an increasing palor spreading over the peritoneum, due to contraction of the vessels. In a short time, however, if the beating is not interrupted, a dilatation of the vessels takes place which is ultimately increased to complete paralysis of their walls. Indirectly also we are able to act upon the blood-vessels by means of the sensitive nerves of the skin, which then reflexly act upon the vaso-motor nerves. *Zabludowski* (Physiologische Wirkungen der Massage, etc., *Archiv für klin. Chir.*, p. 374, 1884,) in his experiments upon dogs, noticed this fact, that there is a reflex action from the sensitive nerves upon the pneumogastric. The natural tonus of this nerve seems to be diminished by massage of the skin. In a dog, upon whom the skin of the thigh was massaged, the pulse, which at the commencement of the experiment was twenty-six per minute, rose quickly to sixty-four. The massage then being kept up for a still longer period it gradually fell, and at the end of the séance had fallen to thirty-six. As a check experiment the vagi were then cut and the massage applied in the same manner as previously. This time the increase in pulse failed to occur. Therefore from these various facts we are entitled to say :

1. Massage has an influence upon the local and general blood supply.
2. Massage executed for a short period of time, up to a certain point, produces contraction of the vessels, and thus localized anæmia.
3. Massage kept up for a longer period produces a dilatation of the walls of the vessels, and thus hyperæmia of the part.
4. Massage acts upon the general circulation by reflexly increasing or decreasing the contractile power of the capillaries, and thus increasing or decreasing the velocity of their circulation.



## 3.—ACTION UPON THE NERVES.

As long as general physiology cannot inform us what nerve conduction really consists of, so long will there remain a number of points in nerve physiology which we will have to acknowledge as facts, but which cannot be satisfactorily understood. The various theories explanatory of the process of nerve conduction have been very numerous: The direct mechanical theory, according to which a movement of the entire nerve is produced, analogous to the ringing of a bell by pulling upon a wire; the theory of wave-like propagation; the electrical theory, upon the strength of *Dubois-Reymond's* experiments; the theory of a chemical change in the nerves,—all these have been advanced, accepted for a time, and ultimately either rejected, or labelled with the Scotch verdict of “not proven.”

Lately *Mortimer Granville* has advanced the theory that all cells and fibres vibrate during action, and thus has endeavored to explain the results attained by his so-called “nerve-vibration,” to which we shall again refer.

*Heitzman* and others, for whom cells do not exist, and for whom the entire body is one mass of connected living matter, believe that nerve conduction consists in a contraction of this living matter, propagated by contiguity.

These latter theories, also, do not fill the void any more than the former. We will be obliged to keep strictly to those physiological facts which have been gained by experiments, and leave the correct theory to be proven later, if possible. What light can be cast upon the subject by this mode of examination will have to suffice. What we do know positively is, that the nerve is not only an intermediary between excitable parts, but that it can also be excited itself in any part of its course. This action of excitation consists only in that, that the process of conduction, whatever that may be, which is normally originated in the excitation organ, is artificially introduced at any part in the course of the nerve. We know that physiologically such excitations in the course of nerves do not occur; but we also know that the result is always the same, and is entirely independent of the seat of irritation. It is totally immate-

rial whether the irritation originates from the physiological point, or whether it is artificially introduced at any point along the nerve. Irritation of a motor fibre always produces contraction, whether this irritation occur as the result of will power, of reflex action, or is artificially produced; and so also irritation of a sensitive fibre produces sensation, and that of any nerve of special sense will produce that special sense, as, for instance, pressure upon the optic nerve will produce an impression of light. It is important for us to recognize these phenomena, and to know the laws which govern them. What process it is that takes place during their production, and upon which they are dependent, is after all, for our purposes, only of secondary importance. The facts, then, which will probably elucidate the action of massage upon nerves better than any amount of theorizing, are those physiological experiments which were made with a view to determine the action of mechanical irritants in reference to the excitability of nerves. In the majority of physiological experiments made to determine this point electricity was made use of as the source of irritation. Unfortunately, however, this force consists of a number of conglomerate factors, chemical, thermal, and perhaps some unknown ones, which render the deductions from experiments so conducted somewhat difficult. Independently of this there are other reasons which make the results of these experiments with electricity useless for our purpose. These reasons consist in the diffusion of the current, in the unipolar action, etc. The excitant to be used, in order to be made available for comparison with massage, must be capable of being applied directly to a nerve without producing any chemical change in its substance, and at the same time of being so localized as to act only upon a single spot. These factors we have in purely mechanical irritants, as well as in massage. In the experiments with purely mechanical irritants, pressure, extension, and percussion are the ones which have been most used. In practical massage these three manipulations, especially the last one, will be found to possess the greatest action upon nerves. The results of these physiological experiments will, then, satisfactorily explain the phenomena produced upon nerves by massage.

*a.—Tapotement—Percussion.*

Physiologically, one of the oldest known facts in experimental nerve physiology is probably that every mechanical irritation, from a slight touch to entire crushing of the nerve, can produce a contraction of the muscle supplied by the irritated nerve. In *Haller's* "Physiology," published in 1766, attention is called to this fact, and we also there find an acknowledgment of its having been known by the ancients. Haller made use of simple touching, cutting, or tying as an irritant. *Haidenhain*, in 1856, by a process of reasoning and by deductions from the above and from other well-known facts, arrived at the idea that mechanical irritation, not sufficiently strong to produce disintegration of its constituent elements, might, nevertheless, cause sufficient action to produce excitation.

He therefore made experiments in this direction, and the results proved the correctness of his supposition. Thus by inducing strong vibrations in a pair of forceps and holding them to a nerve, he produced a true tetanus in the muscle supplied by the nerve. The tips of the forceps were covered with ivory plates, and these were placed in direct contact with the nerve. Thus every possibility of electrical action was excluded. After this Haidenhain constructed a special apparatus for tetanizing muscles, and called it tetanomotor. This apparatus consists of an ivory hammer, which, being drawn upward by means of an electro-magnet, is allowed to fall down upon the nerve whenever the connection is broken. By these experiments the proof was gained that it is not necessary to destroy a nerve in order to mechanically excite it. There was very little more known about the reaction of nerves to mechanical blows than this until about ten years ago. The reaction of nerves to single mechanical blows is even of more importance for our purpose than that of mechanical tetanization of a nerve. These, however, have been employed in physiological experiments even less than the latter. The experiments of *Eckhard* and of *Wundt* ("Untersuchungen zur Mechanik der Nerven," Bd. i., pp. 196–202, 1871) are the only important ones. Wundt's experiments were addressed particularly to the investigation

of the secondary or late action of single blows falling upon a nerve. He came to a very important conclusion, and one which is of great service to us in enabling us to comprehend the action of massage in general and of tapotement in particular, and that is: *Weak mechanical excitation, which is insufficient to produce a contraction*, nevertheless increases the irritability of the nerve to directly applied electrical currents; or, in other words, an amount of irritation so small as to be unable to produce any contraction of a muscle, is, however, able to produce an increased excitability. The most careful and most complete experiments in this field are those of *Tigerstedt* ("Studien über mechanische Nervenreizung," i. Abth., Berlin, 1880). The apparatus which he used is rather complicated, as may be seen from the following qualities which it possesses. For a full description we refer to the original work. 1. It allows of the measurement of the intensity of the irritation. 2. It admits of an increase in the force of the irritation from zero to a given maximum. 3. It allows the nerve to be irritated at any point along its course, from its exit from the spinal column to its entrance into the muscle, without moving the nerve. 4. It is so constructed that the falling weight rests only the shortest possible time upon the nerve, and thus no more pressure than necessary is exercised upon it. 5. It allows of the simultaneous application of some other mechanical irritant than blows from the hammer. 6. It prevents exsiccation of the nerve. 7. The apparatus may be used together with the ordinary instruments for recording muscular movements. *Tigerstedt* thus found that, in allowing a certain amount of time to intervene between each experiment, the nerve possesses a great deal of endurance, and that, if he was careful that it did not dry out, but kept up a supply of moisture, *no particular destructive action was produced by the mechanical irritation*. He then made another series of experiments in reference to the endurance of nerves to quickly consecutive strokes. It was thereby shown that *the nerve endures these quickly repeated blows very well*.

During the course of these experiments several peculiarities were noticed, which deserve special mention, and

which are particularly important in bearing a direct practical relation to massage. If one and the same place in a nerve was repeatedly irritated at short intervals, it was noticeable that the contractions increased in intensity up to the third or fourth contraction, which limit being reached, they remained stationary for a certain length of time. If an interval of from 2-3 minutes was allowed to elapse between each irritation, it was noticeable that, after a repetition of irritation of the same amount of intensity, no similar increase in the force of the contraction took place. Therefore the cause of this phenomenon, the increased excitability, must be sought for in the frequent repetition of the irritation within a short space of time. Such repeated irritations, therefore, seem to produce some molecular change in the structure of the nerve which enables it to react more forcibly to one and the same excitation. When the maximum has been reached it remains constant during a long period of time, before, in consequence of exhaustion of the nerve, the muscular contractions begin to decrease in intensity. Practically, what we know of the action of tapotement corresponds to the results of these experiments.

1. Light tapotement increases the irritability of the nerve.

2. Quickly repeated tapotement increases the contractility of the muscles supplied by the nerve operated upon.

3. Slow and strong tapotement produces exhaustion of the nerve.

These statements can none of them, except the first, be taken categorically. The second is true only up to a certain point, but if kept up for a long period of time, exhaustion of the nerve occurs. The action of tapotement upon *sensitive nerves* is similar to its action upon motor ones; just as light tapotement increases the irritability of a motor nerve and thus promotes the contractile power of the muscles, so when applied over a sensitive nerve we notice at first an increase of the pain, which, however, soon subsides, then disappears, and ultimately is replaced by complete anæsthesia. Naturally, the more delicate the nerve in its anatomical con-

figuration, the less is the amount of force and time necessary to reach this result. Experiments upon man or animals in reference to the excitability of sensitive nerves to mechanical irritants, do not exist. Whatever investigations may be made in this direction will naturally be entirely subjective, as the results will depend upon the evidences of pain given by the subject. *DeWatteville* has found that there is cumulative action in sensitive nerves analogous to that observed in motor ones. *DeWatteville's* experiments were conducted with electricity as an irritating agent. Very soon after beginning to use percussion as a treatment for pain, we made a similar observation in reference to the action of tapotement upon sensitive nerves. The greater the frequency of the blow, the more the pain is increased. Thus very rapid and light percussion applied to a sensitive nerve which is the seat of pain, will increase that pain instead of alleviating it. This fact, however, only holds good up to a certain point, for if we continue the percussion for a sufficient length of time we will eventually obtain relief. Practically, however, this is not feasible, for many patients cannot endure the increasing pain long enough to reap the benefit of their perseverance. Therefore, notwithstanding opinions to the contrary, it is better to begin the treatment of a neuralgia with strong and slow blows, or with some other form of massage—effleurage for instance,—and only when the pain has almost subsided, to make use of rapid blows. Naturally the rapidity and the force of the blow will depend upon each individual case. A light blow over the sciatic, would become a very severe one if applied over the supra-orbital. These practical points were obliged to be interpolated here in order to explain the cumulative action to mechanical excitants, which takes place in sensitive nerves.

*b.—Pressure and Extension.*

All effleurage, or kneading, applied over nerves produces extension of the terminal filaments. For this reason we can treat of the various manipulations, with the exception of percussion, in reference to their physiology under the one heading of "Pressure and Extension." This is all the more

justifiable because, as has been shown by *Valentin* about twenty years ago, extension of a nerve acts analogously to an increase of pressure applied to it; for by extension the nerve sheath presses laterally upon the softer medullary substance, and the medulla in its turn presses upon the axis-cylinder. Therefore, the experiments made in reference to the action of one, will also cast light upon the action of the other. Physiologically, during every movement that is made, even through every change in the position of the body, an extension and pressure is exercised upon the nerves: extension, by the movements themselves; and pressure, by contraction of the various muscles and groups of muscles. For this reason we need not be surprised that physiologists early began to inquire into the *modus operandi* of extension and pressure, naturally without a thought of the practical bearing of the result. *Valentin*, who was the first to experiment in this direction, produced extension of the nerves, by hanging weights to the nerve trunks of the extremities of a decapitated frog. The excitation used was the induced current. The result of his experiments was,—that a moderate amount of extension has no influence upon the excitability of the nerves, whereas a greater amount reduced it. Here, no mention of an increased irritability, occurring at any time, is made. *Haber* (*Archiv für Physiologie*, 1859, p. 109), and later *Cornet* and *Ranke* (*J. Ranke: "Die Lebensbedingungen des Nerven,"* Leipzig, 1868, p. 122), found that a certain amount of extension, the amount, however, not being specified, increases this irritability. *Schleich* (*Zeitschrift für Biologie*, 1871, p. 370), *Tutschek* (Ein Fall von einer Reflexepilepsie, geheilt durch Nerven-*dehnung*. Dissert., München, 1875), *Conrad* (Experimentelle Untersuchungen über Nerven-*dehnung*. Dissert., Greifswald, 1876), and *Vogt*, all did not succeed in adding any thing to our knowledge. *Tigerstedt*, in 1880, made the action of the milder forms of extension a special object of study. He made a number of experiments in reference to the increase and decrease of irritability of a nerve after extension, and his results were constant and conclusive. They show incontrovertibly, that the irritability of the nerve increases under

slight extension, but that it again sinks when extension is increased above a certain point. In reference to the first of these two points, he found that a gentle extension, which was gradually increased from 0-25 grammes upon the sciatic nerve of a frog, produced a gradual and continuous increase in the irritability of the nerve. This point, however, being surpassed, a decrease began to take place. Practically we can, of course, not express in definite terms what amount of pressure or extension is to be applied in order to produce the desired effect upon certain nerves. We can only qualify it by the terms light and strong. The diameter of the nerve, the elasticity and thickness of the perineurium and of Schwann's sheath, and even the individual irritability will naturally exert a modifying influence. One thing is sure, and that is that pressure applied directly has more influence upon the nerve than when applied indirectly in the form of extension.

*Zederbaum* (*Archiv f. Physiologie*, 1883, p. 160. *Nervendehnung und Nervendruck*), whose experiments in reference to direct pressure are the most valuable, has shown that when a large amount of pressure is applied to a nerve at once, the irritability decreases rapidly, but that this decrease is not nearly so marked and takes place more slowly, when the pressure is gradually increased up to the same amount. The action of pressure or extension upon sensitive nerves corresponds very nearly to that upon motor ones. *Luderitz* (*Versuche über die Einwirkung des Drucks auf die sensiblen und motorischen Nerven. Zeitschr. f. klin. Med.*, Berlin, 1881, Bd. ii., Heft i.), however, has shown that they possess a greater power of resistance than motor nerves, and that motor nerve fibres are much more easily paralyzed by continuous pressure than sensitive fibres. What we really know then, and what is of practical value, is:

A mild pressure or extension, increased up to a certain point, will correspondingly increase the irritability of a nerve; increased beyond that point, it will decrease or abolish it. This change in the irritability of the nerve, be it an increase or decrease, lasts for some time after the source of pressure or extension has been removed.



## 4.—ACTION UPON THE MUSCLES.

Massage, acting as a mechanical irritant, exerts a special influence upon muscles. Besides its indirect action through the nerve which supplies the muscle, and by means of the increased circulation which it produces, thus increasing the nutrition, it also exerts influence upon the contractile power of the muscular fibres themselves. Thus it is necessary to keep muscle irritation and nerve irritation distinctly separated. According to *Pick* (*Zur Lehre von den Wirkungen der mechanischen Muskelreizung. Prager med. Wochenschrift*, 1884, pp. 123, 136, and 145), the first observations in reference to the idio-muscular furrow, which is the contraction of a muscle limited to the point of irritation and brought about by mechanical excitants, were made by *Bennet-Dowler* in 1846. In 1851 *Schiff* commenced his work upon this subject, and to him we are indebted for the expression, "idio-muscular" contraction. If in a warm-blooded animal he stroked or percussed a muscle in a transverse direction to the course of the fibres, a localized stationary elevation of the fibres at the point of irritation was noticed. The eminence which was thus formed lasted for some time after removal of the irritant. This phenomenon was noticeable not only upon living but also upon dead animals. In 1861, *Auerbach* (*Ueber topische Muskelreizung. Jahresbericht der Schlesischen Gesell.*) made similar experiments upon human beings, but using the blows from a percussion hammer as the irritant. He found that in the majority of instances, the result of this was the formation of a cone-shaped eminence at the point of irritation, and that this cone remained unaltered for a period varying from three to five seconds, after which time it gradually disappeared. Lately *Zabludowsky* has experimented directly as regards the action of massage upon the muscles. He has shown that muscles of an uninjured frog, after having been exhausted by a series of maximum blows from an induction coil, regained their power rapidly under massage, whereas rest alone was of little service. Upon rabbits also he showed that the exhausted muscles recuperated much more completely under the influence of massage than after rest alone;

and that, furthermore, in some instances the massaged muscles were able to accomplish more than the non-exhausted muscles which had not been massaged. Also upon human beings he noticed that after exhausting physical work, a short rest (fifteen minutes) did not produce material recuperation, but that after the same period of massage the amount of work could be doubled. Thus, for instance, in one case the person lifted a weight of one kilogram 840 times, at intervals of one second. The weight was placed upon a table, the forearm also resting horizontally upon it. The weight was each time lifted to the shoulder by flexion of the elbow. After this amount of work the subject was unable with the utmost exertion to accomplish any more. The arm was then massaged for five minutes, after which he was able, without any exertion, and in the same rhythm, to lift the same weight, in the same manner, 1,100 times. He has also shown experimentally what we have long known practically, that the diseased condition which frequently arises in over-exerted muscles, or in extremely irritable ones, known under the designation of "contracture," can be entirely relieved by massage. In his experiments he produced a tetanus in the muscles of the leg of a rabbit; then allowed them to recuperate by rest, then again irritated until ten minutes' rest was unable to produce any recuperation. Ten minutes' massage on the other hand being substituted for the ten minutes' rest, the muscle was not only restored to its original state, but was enabled to vibrate four to five times as long. That massage also directly increases the nutrition of muscles is a fact which needs very little explanation. It is well known that contraction of a muscle produces heat in that muscle during such contraction, and therefore any increase in the contractility of the muscle will increase the amount of heat produced in it, and thus also increase its nutrition. *Danilewsky* has shown that in addition to this, and independently of the contraction produced, any mechanical shock produces heat in the muscles to which it is applied; the heat production of a muscle is therefore increased in two ways by massage.

Before closing this physiological chapter, a few remarks

on the special action of some forms of massage must be referred to. Particularly the hypnotic action of effleurage merits attention. Effleurage has by many writers been denied the possession of any special qualities, and its chief function asserted to be the habituation of the patient to the hand of the operator, and to prepare him to more easily endure the more energetic rubbings which are to follow. This opinion does not accord with well-known facts. The anæsthetic results, described by observers like v. Mosengeil, *Berghman* and *Helleday* and *Gerst*, obtained after effleurage, prove that it has an action upon the nerve filaments of the skin. But besides this action there is another, and it is upon this that we desire to lay particular stress, that is, its hypnotizing influence. While treating very impressionable patients, hysterical women particularly, it has occasionally happened to us that after a few minutes' effleurage they entered into an hypnotic state. The point that is important is to recognize this action, and to distinctly separate it from any remedial power that massage possesses. Otherwise we may occasionally be led astray by phenomena which are produced in a subject through effleurage, but which could just as easily have been brought about by any other of the well-known modes of producing hypnotism. The following citations from several works on hypnotism show that this fact is acknowledged by investigators in that field. All the more strange, that more notice has not been accorded to it by writers on massage.

*Weinhold, A. F.* ("Hypnotische Versuche," Chemnitz, 1880) says: "For an intense development of the hypnotic condition, besides continuous fixation, *the irritation of the skin produced by stroking*, and the influence of the imagination, are of great importance." "The action of the irritation of the skin produced by stroking, seems to depend in different persons upon the various manners of stroking. It appears that, in some, the application of pressure which is hardly appreciable; in others, that of a strong pressure, is the most operative; whereas still others seem to be more easily influenced by the exceedingly weak irritation, which is hardly appreciated by a skin of normal sensibility, of the current of

air produced by stroking without actually touching the skin."

*Schneider, G. H.* ("Die psychologische Ursache der hypnotischen Erscheinungen," Leipzig, 1880): "Stroking of the skin produces continuous muscular contractions, stiffness of the joints, and anæsthesia." Our advice, therefore, briefly is: if you wish to subject massage to reliable tests, beware of hysterical subjects.

The action of massage of the neck merits a few words. This form of massage is principally depletory in its action; and that this is an energetic one may be understood when we take into consideration the venous configuration of the parts to which it is applied. It exerts a general derivatory action upon the brain and its membranes, and, therefore, by its use the pressure of blood in the cranium may be lowered in a very short time. In general terms, its action corresponds to that claimed for compression of the carotids, the same results being obtained by another route and for obvious reasons in a more complete and less injurious manner. It may, therefore, be used either as a preparatory remedy to the use of other depletories, or, as can be clinically shown, its energetic action may be made use of in many conditions dependent upon an increased flow of blood to the brain, or an intercepted reflux producing stasis.